

1.4938/X12CrNiMoV12-3 represents a premium martensitic [stainless steel](#) specifically developed for critical high-temperature applications in turbines and aerospace. Its balanced composition provides an excellent combination of strength, creep resistance, and corrosion resistance at temperatures up to 600°C. The strict quality control requirements across OEM specifications ensure reliable performance in demanding applications.

Austenitic [stainless steels](#) for turbine applications offer exceptional high-temperature strength, creep resistance, and corrosion resistance in demanding environments. This guide provides a comprehensive technical analysis of three important grades: 1.4962 (X12CrNiWTiB16-13), St17-13W (GE specification), and their equivalents.

Applications

X12CrNiWTiB16-13 / 1.4962 Applications

- **Classification:** Austenitic stainless steel with titanium and boron stabilization
- **Applications:** Gas turbine blades, combustion components, high-temperature fasteners
- **Key Features:**
 - Excellent creep resistance at temperatures up to 750°C
 - Good oxidation resistance
 - Typically supplied in solution annealed condition (+A)

St17-13W (GE Specification) Applications

- **Classification:** Warm-worked austenitic stainless steel (GE proprietary)
- **Applications:** Critical rotating components in gas turbines, especially GE designs
- **Key Features:**
 - Enhanced strength through warm working
 - $R_{p0.2} \geq 440$ MPa in warm-worked condition
 - Optimized tungsten content for creep resistance
 - Typically supplied in warm-worked condition (+HT)

Equivalent or Similar Grades - Chemical Composition

| Element | X12CrNiWTiB16-13 / 1.4962 | St17-13W (GE NB 00144) | Similar Grades |
|---------|---------------------------|------------------------|----------------|
| C | 0.08-0.16 | 0.08-0.15 | 0.08-0.20 |
| Si | ≤1.00 | ≤0.80 | ≤1.00 |

| Element | X12CrNiWTiB16-13 / 1.4962 | St17-13W (GE NB 00144) | Similar Grades |
|---------|----------------------------------|-------------------------------|-----------------------|
| Mn | ≤2.00 | ≤1.00 | ≤2.00 |
| P | ≤0.045 | ≤0.035 | ≤0.045 |
| S | ≤0.015 | ≤0.005 | ≤0.015 |
| Cr | 15.0-17.0 | 15.50-17.50 | 15.0-18.0 |
| Ni | 12.0-14.0 | 13.00-14.50 | 12.0-15.0 |
| W | 2.0-3.0 | 2.50-3.00 | 2.0-3.5 |
| Ti | 5×C min, ≤0.80 | 5×C min, ≤0.85 | 5×C min, ≤1.00 |
| B | 0.003-0.010 | ≤0.0060 | 0.003-0.010 |
| Mo | ≤0.50 | ≤0.50 | ≤1.00 |
| V | ≤0.10 | ≤0.10 | ≤0.20 |

Note: St17-13W has stricter sulfur control (≤0.005%) compared to standard grades

Mechanical Properties

Room Temperature Mechanical Properties

| Property | 1.4962 / X12CrNiWTiB16-13 | St17-13W (GE Spec) |
|---------------------------|----------------------------------|---------------------------|
| 0.2% Proof Strength (MPa) | 240-400 (+A) | 440-650 (+HT) |
| Tensile Strength (MPa) | 540-740 (+A) | ≥590 (+HT) |
| Elongation A5 (%) | ≥35 (+A) | ≥20 (+HT) |
| Impact Energy (J) | ≥80 | ≥70 |
| Hardness (HB) | 160-220 (+A) | 180-240 (+HT) |

High-Temperature Mechanical Properties (650°C)

| Property | 1.4962 / X12CrNiWTiB16-13 | St17-13W (GE Spec) |
|---------------------------|----------------------------------|---------------------------|
| 0.2% Proof Strength (MPa) | ≥180 | ≥220 |
| Tensile Strength (MPa) | ≥300 | ≥350 |
| Elongation A5 (%) | ≥25 | ≥18 |

Creep and Rupture Properties

1.4962 / X12CrNiWTiB16-13 Creep Performance

Creep Rupture Strength at 650°C:

- 10,000 hours: ≥ 120 MPa
- 100,000 hours: ≥ 90 MPa

Creep Rate: Typically $< 5 \times 10^{-8}$ %/h at 650°C under 100 MPa stress

St17-13W Creep Performance

- Shows superior creep resistance compared to standard grades
- 100,000 hour rupture strength at 650°C typically ≥ 100 MPa
- Warm working enhances creep resistance at intermediate temperatures

Physical Properties

| Property | 1.4962 / X12CrNiWTiB16-13 |
|---|----------------------------------|
| Density (g/cm ³) | 7.9 |
| Thermal Conductivity (W/m·K) | 15 (at 20°C), 22 (at 700°C) |
| Specific Heat (J/kg·K) | 500 (at 20°C), 650 (at 700°C) |
| Thermal Expansion (10 ⁻⁶ /K) | 16.0 (20-100°C), 18.5 (20-700°C) |
| Electrical Resistivity (Ω·m) | 0.95×10^{-6} |
| Elastic Modulus (GPa) | 195 (at 20°C), 150 (at 700°C) |

Heat Treatment

1.4962 / X12CrNiWTiB16-13 Heat Treatment

Solution Annealing (+A):

- Temperature: 1050-1150°C
- Cooling: Rapid cooling (water quenching preferred)
- Purpose: Dissolve carbides and achieve homogeneous austenitic structure

Stabilization Annealing (optional):

- Temperature: 850-950°C
- Cooling: Air cooling

- Purpose: Precipitate TiC and improve creep resistance

St17-13W (GE Specification) Processing

Warm Working (+HT):

- Working temperature: Typically 500-700°C
- Degree of deformation: Proprietary to GE
- Results in enhanced strength through work hardening

Final Condition: Warm Worked (+HT) per GE specifications

Processing Performance

Forging and Hot Working

- Recommended hot working temperature range: 1150-900°C
- Should be cooled rapidly after hot working to prevent carbide precipitation
- Warm working (for St17-13W) performed at 500-700°C

Machinability

- Machinability rating: ~40% of free-cutting steels
- Recommended tools: Carbide tools with chip breakers
- Cutting speeds: 20-40 m/min for turning operations
- Requires rigid setups due to work hardening tendency

Welding Characteristics

- **Weldability:** Fair with proper precautions
- **Recommended Processes:** GTAW (TIG), PAW (plasma arc)
- **Preheat:** Generally not required but 100-150°C helpful
- **Post-Weld Heat Treatment:** Full solution annealing recommended for critical applications
- **Filler Metals:** Matching composition or higher alloy grades (e.g., Ni-base alloys)

Microstructural Requirements

- **Austenitic Structure:** Fully austenitic after solution treatment
- **Carbide Precipitation:** Controlled distribution of TiC and M₂₃C₆
- **Grain Size:** ASTM 4-6 typically specified
- **Delta Ferrite:** Generally not permitted

- **Inclusions:** Controlled per ASTM E45 (Type A <2, Type B <1.5)

Equivalent Grades

| Country/Standard | Equivalent Grade |
|------------------|--------------------------|
| Germany (DIN) | 1.4962, X12CrNiWTiB16-13 |
| USA (GE Spec) | St17-13W |
| USA (ASTM/UNS) | S66286 |
| Japan (JIS) | SUH660 |
| China (GB) | 1Cr15Ni36W3Ti |
| Russia (GOST) | ЭИ787 |
| Europe (EN) | X12CrNiWTiB16-13 |

Quality Control and Testing Requirements

- **Chemical Analysis:** Melt analysis required for all specified elements
- **Mechanical Testing:**
 - Tensile, impact, hardness testing required
 - Testing from center of cross-section for St17-13W
- **Non-Destructive Testing:**
 - Ultrasonic testing for critical applications
 - Dye penetrant inspection for surface defects
- **High-Temperature Testing:**
 - Elevated temperature tensile tests at service temperatures
 - Creep rupture testing for qualification

Recent Developments and Modifications

Recent updates to St17-13W specification (as seen in the GE document) include:

- Stricter control of sulfur content ($\leq 0.005\%$)
- Modified tungsten range (2.50-3.00%)
- Updated mechanical property requirements
- Enhanced documentation requirements (EN 10204 Type 3.1)